IN THE SPECIFICATION

Please amend the specification as follows:

Please amend paragraph [0003] as follows:

To facilitate the dissipation of the heat generated by a die, an IHS may be affixed to the die and maybe used in conjunction with a heat sink. The IHS is affixed to the die with a layer of thermal interface material that is used to provide some adhesion between the IHS and the die and transfer heat from the die to the IHS. In addition, a heat sink may be placed on top of the IHS with a layer of a thermal interface material placed between the IHS and heat sink to facilitate a limited amount of adhesion and transfer heat from the IHS to the heat sink. The heat sink may have vertical fans extending therefrom ~~there from~~ to increase the surface area of the heat sink and facilitate the transfer of heat from the IHS to the ambient air. As would be appreciated by one of ordinary skill in the art these heat sinks may take many different forms and may include a small electric fan.

Please amend paragraph [0013] as follows:

FIG. 3 is an example of an assembled package with the IHS 10 having deformed by bowing in in the center due to differences in package materials coefficients of thermal expansion or to physical manipulation and/or temperature gradients in an example embodiment of the present invention;

Please amend paragraph [0014] as follows:

FIG. 4A is an example of a Moiré ~~Morié~~ Fringe image of a free-standing IHS 10 as supplied by a manufacturer in an example embodiment of the present invention;

Please amend paragraph [0015] as follows:

FIG. 4B is an example of a Moiré ~~Morié~~ Fringe image of an IHS 10 at room temperature after being attached to the substrate in an example embodiment of the present invention;

Please amend paragraph [0016] as follows:

FIG. 4C is an example of a Moiré ~~Morié~~ Fringe image of an IHS 10 assembled into a package, where the entire package is being soaked at 90 degrees Celsius in an example embodiment of the present invention;

Please amend paragraph [0021] as follows:

FIG. 8 is an example of the process [[of]] used to generate the IHS 10 shown in FIGs. 5A and 5B resulting in the IHS 10 shown in FIGs. 6 and 7 in an example embodiment of the present invention; and

Please amend paragraph [0022] as follows:

FIG. 9 is an example of the process [[of]] used to generate the IHS 10 shown in FIGs. 5A and 5B resulting in the IHS 10 shown in FIGs. 6 and 7 in an example embodiment of the present invention.

Please amend paragraph [0024] as follows:

FIG. 1 is an example of a package prior to assembly in an example embodiment of the present invention. FIG. 1 illustrates a package having a die 50 attached to a substrate 30 using epoxy 60 with a finite amount of a thermal interface material (TIM) 20 placed on top of the die 50. This TIM 20 serves at least two primary purposes. First, it acts to conduct heat from the die to the integrated heat spreader (IHS) 10. Second, it also provides some adhesion between the IHS 10 and die 50. During the manufacturing process the IHS 10 is pressed down upon the TIM 20 and adhesive 40. Thereafter, thermal interface material (TIM) 80 would be placed on IHS 10 with the heat sink 70 placed on top of IHS 10. TIM 80 serves ~~servers~~ the same function as TIM 20 and may be composed of the same material. Throughout the foregoing discussion the term package will refer to the combination of, but not limited to, the substrate 30, epoxy 60, die 50, thermal interface material 20, IHS 10, thermal interface material 80, heat sink 70 and adhesive 40.

Please amend paragraph [0026] as follows:

FIG. 3 is an example of an assembled package with the IHS 10 having deformed by bowing in the center due to physical manipulation and/or temperature fluctuations or differences in material coefficients of thermal expansion in an example embodiment of the present invention. The sole difference between FIG. 2 and FIG. 3 is the nature of the deformation of the IHS 10. As would be appreciated by one of ordinary skill in the art how the IHS 10 may be deformed is dependent on the materials it is made of, the manner of handling, and the heat it is exposed to by die 50. Therefore, figures 2 and 3 are provided merely as examples of how an [[and]] IHS 10 may deform. Regarding the heating of the IHS 10 this is dependent upon how die 50 generates and dissipates heat. For example, die 50 may generate heat at a specific location such as the center of the die 50 or it may dissipate heat at the outer edges of the die 50. The manner in which die 50 dissipates heat would directly affect the deformation seen in the IHS 10. Since all other elements shown in FIG. 3 remain the same as that shown in FIG. 2, no further discussion of these elements will be provided here.

Please amend paragraph [0027] as follows:

FIG. 4A is an example of a <u>Moiré</u> ~~Morié~~ Fringe illustration of an IHS 10 as supplied by a manufacturer without being attached to a substrate 30 in an example embodiment of the present invention. It should be noted that the sensitivity of the <u>Moiré</u> ~~Morié~~ Fringe illustration is 12.5 microns per fringe and that FIG. 4A is a top view of IHS 10. As indicated in FIG. 4A, as received from the manufacturer the IHS 10 is effectively flat.

Please amend paragraph [0028] as follows:

FIG. 4B is an example of a <u>Moiré</u> ~~Morié~~ Fringe illustration of an IHS 10 after being at room temperature as assembled into a package in an example embodiment of the present invention. As with FIG. 4A, it should be noted that the sensitivity of the <u>Moiré</u> ~~Morié~~ Fringe illustration is 12.5 microns per fringe and that FIG. 4B is a top view of IHS 10. As indicated in FIG. 4B, after attachment to substrate 30 and at room temperature the IHS 10 significantly

deformed as compared to that received from the manufacturer of the IHS 10. Since assembly occurs at room temperature, but curing of the sealant occurs at elevated temperatures, the entire package will warp when cooled to room temperature as seen in Fig. 4B. This can affect the adhesion between the heat sink 70 and the IHS 10 using the thermal interface material 80, as shown in FIG. 2. Further, it would affect the thickness of the thermal interface material 80 and thereby the heat dissipation capabilities of the heat sink 70. In Fig. 4B a substrate is attached to the IHS, however, it is not visible in the picture.

Please amend paragraph [0029] as follows:

FIG. 4C is an example of a <u>Moiré</u> ~~Morié~~ Fringe illustration of an IHS 10 in an assembled package, where the package is being exposed to a 90 degree Celsius heat soak after attachment to substrate 30 (not shown) in an example embodiment of the present invention. As previously mentioned regarding figures 4A and 4B, it should be noted that the sensitivity of the <u>Moiré</u> ~~Morié~~ Fringe illustration is 12.5 microns per fringe and that FIG. 4c is a top view of IHS 10. As indicated in FIG. 4C, as the temperature of the entire package is increased to 90 degree Celsius, the IHS 10 actually flattens slightly as compared to that shown in FIG. 4B that is at room temperature. However, there is still significant deformation involved in the IHS 10 shown in FIG. 4C to the point where two small bumps are formed in the IHS 10.

Please amend paragraph [0030] as follows:

Figures 4A through 4C are provided merely as examples of the type of deformation that may be seen in an IHS 10. As would be appreciated by one of ordinary skill in the art, the type of deformation that would be seen in the IHS 10 would depend upon the type of manipulation received during assembly, the materials the IHS 10 and the other package components are composed of, the temperature range the IHS 10 is exposed to, etc. Therefore, in designing the IHS 10 to compensate for any deformation seen it is necessary to provide a process and method that can handle any deformation possible. Further, as would be appreciated by one of ordinary skill in the art, a <u>Moiré</u> ~~Morié~~ Fringe analysis is only one method of many for measuring deformation [[is]] in the IHS 10. Other examples would include utilizing laser or even a touch

probe to measure the deformation. All these methods of measuring the shape of the IHS 10 will collectively be referred to as a dimensional analysis from this point forward.

Please amend paragraph [0035] as follows:

FIG. 7 is an example of an assembled package in which the IHS 10 has been processed utilizing the compensated IHS 10 shown in FIGs. 5A or 5B and the logic shown in either FIG. 7 or FIG. 8 taking into consideration a hotspot on die 50 in an example embodiment of the present invention. The package shown in FIG. 7 is identical to that shown in FIG. 6 with the exception that additional material 90 has been added to the IHS 10 in order to facilitate the transmission of the heat from a specific location on die 50 to heat sink 70. This specific location on die 50 is referred to as a hotspot since it generates more heat than other portions over the die 50. As would be appreciated by one of ordinary skill in the art, certain areas of the die 50 would generate more heat than others due to the nature of the circuitry at that location. By increasing the thickness of the IHS 10 at that hotspot, it would be possible to increase the heat transfer capacity of the IHS 10 at that location since the distance between the IHS 10 and heat sink 70 would be reduced. Of course, the reverse is also possible and the IHS 10 may be made thinner at selected points.

Please amend paragraph [0038] as follows:

FIG. 8 is an example of the process used to generate the IHS 10 shown in FIGs. 5A and 5B resulting in the IHS 10 shown in FIG. 6 and 7 in an example embodiment of the present invention. Processing begins in operation 800 and immediately proceeds to operation 810. In operation 810 a series of packages are built which include IHS 10 elements that are flat in the as received condition from the supplier. Thereafter, in operation 820 the packages are heat soaked or elevated to an approximate temperature at which the die 50 is anticipated to operate at. In operation 830, a dimensional analysis is performed on the IHS 10 in each package. This die dimensional analysis may use ~~comprising using~~ a Moiré ~~Morié~~ Fringe analysis or some other technique for measuring the deformation in the IHS 10 in each package. As part of the analysis performed in operation 830 a statistical analysis is performed on the results of the dimensional

analysis received for each IHS 10. In this manner an average deformation for each IHS 10 can be determined. Thereafter, processing proceeds to operation 840 where a series of sets of IHS 10's [[is]] are generated that have a slightly varying curvature to compensate for the warpage seen by the die dimensional analysis performed in operation 830. Each set of IHS 10's would comprise a statistically significant number of IHS 10's that would be of consistent shape with one another within a set, but would <u>vary</u> [[very]] in degree of compensation from one set to another. In this manner it would be possible to select the degree of compensation that best corrects the warpage seen. However, as would be appreciated by one of ordinary skill in the art, alternatively a simple series of IHS 10's may be manufactured and installed in packages. This simple series of IHS 10's may simply vary in the degree of compensation or curvature to form an equal distribution of IHS 10's of varying curvatures. In operation 845 the IHS <u>10's</u> [[10 is]] are assembled into packages which comprise all the elements shown in FIGs. 1 through 3.

Please amend paragraph [0039] as follows:

Still referring to FIG. 8, processing then proceeds to operation 850 in which the set of packages or package that has the flattest package when powered on is selected as the template for the IHS 10 design. Thereafter, in operation 860 it is determined if die 50 has any hotspots therein. In the preferred embodiment operation 860 may be performed on the assembled package with the heat sink 70 attached. In this way the correct stress and thermal conditions seen in actual use are achieved. In a preferred embodiment the hotspots are determined by temperature sensors contained <u>within</u> ~~with in~~ the die 50 itself. In operation 870 for any hotspots found in die 50, the curvature of the IHS is modified in the area of the hotspot to eliminate it. Thereafter, processing proceeds to operation 880 where the IHS 10 with the compensated shape for warpage and hotspots is manufactured. Processing then proceeds to operation 890 <u>where</u> [[were]] processing terminates.

Please amend paragraph [0040] as follows:

FIG. 9 is an example of the process used to generate the IHS 10 shown in FIGs. 5A and 5B resulting in the IHS 10 shown in FIGs. 6 and 7 in an example embodiment of the present

invention. Processing begins execution in operation 900 and immediately proceeds to operation 910. In operation 910, a finite element model is generated for the entire package including the IHS 10. Finite element models comprise dividing a structure into a fixed number of smaller pieces or elements and inputting each element and its respective coordinates and relationships to other elements into a computer system. In addition, the properties of each element, such as, but not limited to, temperature expansion coefficients, elasticity, heat transfer capability, modulus of elasticity tensile strength, etc. are entered into the finite element model. Processing then proceeds to operation 920 where the pressure points generated by the factory handling equipment, such as, but not limited to, a robot arm and grasping device, are entered into the finite element model. These pressure points would comprise the amount of pressure being placed on specific elements in the finite element model. The pressure experienced ~~experience~~ by these specific elements would be transferred to other elements contained within the model.

Please amend paragraph [0041] as follows:

Still referring to FIG. 9, in operation 930 expansion coefficients and mechanical properties of each element of the package are also entered into the finite element model. In operation 940 the operating temperature of the die 50 is determined and which elements in the finite element model are affected by the temperature increase of the die 50. For example, the epoxy 60 would have a different expansion coefficient than the IHS 10, or the heat sink 70. Processing then proceeds to operation 950 where the hotspots, if any, in the die 50 are identified and the corresponding elements in the IHS 10 are also determined. In operation 960 a finite element model is executed and the warpage of the IHS 10 is determined from the finite element model. Thereafter, in operation 970 the IHS 10 is redesigned to compensate for the warpage seen in operation 960. In operation 980 the finite element model is executed again with the exception that the IHS 10 compensated for the warpage seen earlier is utilized in the model. This would entail replacing the elements of the IHS 10 that are changed with new elements of possibly different shape and [[an]] existing in different positions. Thereafter, in operation 990 it is determined if any warpage can be seen utilizing the compensated IHS 10 in the finite element model. If the warpage is not eliminated in the finite element model then processing returns to

operation 970 where it is repeated. However, if the warpage is eliminated in the finite element model in operation 980, then processing proceeds from operation 990 to operation 1000. In operation 1000 a series of sets of IHS 10's [[is]] are generated that have a slightly varying curvature to the IHS 10 determined by the finite element model. Each set of IHS 10's would comprise a statistically significant number of IHS 10's that would be of consistent shape with one another within a set, but would vary [[very]] in degree of compensation from one set to another. In this manner it would be possible to select the degree of compensation that best corrects the warpage actually seen as opposed to that predicted by the finite element model. As would be appreciated by one of ordinary skill in the art, no matter how well the finite element model is generated it still may not behave precisely as predicted in actual operation. Still further, as would be appreciated by one of ordinary skill in the art, alternatively a simple series of IHS 10's may be manufactured and installed in packages. This simple series of IHS 10's may simply vary in the degree of compensation or curvature to form an equal distribution of IHS 10's of varying curvatures were [[was]] the IHS 10 generated by the finite element model being the medium IHS 10. In operation 1010 the IHS 10's [[10 is]] are assembled into packages that comprise all the elements shown in FIGs. 1 through 3.

Please amend paragraph [0042] as follows:

Still referring to FIG. 9, processing then proceeds to operation 1030 in which the set of packages or package that has the flattest package when powered on is selected as the template for the IHS 10 design. Thereafter, in operation 1040 it is determined if die 50 has any hotspots therein. In the preferred embodiment operation 860 may be performed on the assembled package with the heat sink 70 attached. In this way the correct stress and thermal conditions seen in actual use are achieved. In a preferred embodiment the hotspots are determined by temperature sensors contained within ~~with in~~ the die 50 itself. In operation 1050 for any hotspots found in die 50, the curvature of the IHS is modified in the area of the hotspot to eliminate it. Thereafter, processing proceeds to operation 1060 where the IHS 10 with the compensated shape for warpage and hotspots is manufactured. Processing then proceeds to operation 1070 where [[were]] processing terminates.

Please amend paragraph [0043] as follows:

The benefits resulting from the present invention is that an IHS 10 may be designed that will create an [[and]] approximately flat package even after manipulation and exposure to fluctuations in temperature. With such a near flat package it is possible to effectively and uniformly dissipate heat from a die. In addition, it is possible to increase the heat dissipation capacity of the IHS 10 for specific locations associated with hotspots in a die 50.